Multithreaded Approach for Food and Drink Service Optimization in Party Environments: A Case Study of Waiter-Assisted Guest Dining (May 2024)

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ABSTRACT This study presents a solution for optimizing the process of serving guests in a party environment using a multi-threaded approach. At the party, a specific number of guests are provided with a certain amount of food and drinks. The study examines a thread-based approach to ensure fair distribution and service of these food and drinks among the guests. Threads managed by a waiter monitor whether a specific food or drink tray is full or empty and refill it if necessary. Guest threads consume each type of food and drink at least once within defined limits. The results of the study demonstrate that the multi-threaded approach is an effective method for service optimization in party environments.

INDEX TERMS Multi-threading, Optimization, Food Service, Drink Service, Party Environment, Semaphore, Java.

I. INTRODUCTION

In social gatherings such as parties, efficiently managing the service of food and drinks to guests is essential for ensuring a pleasant experience. However, traditional approaches to serving large groups of guests in such environments may lead to inefficiencies and uneven distribution of resources. This study addresses this challenge by proposing a novel approach to optimize the process of serving food and drinks in a party environment using multi-threading techniques.

The aim of this study is to develop a system that ensures fair distribution of food and drinks among guests while maximizing resource utilization and minimizing wait times. By employing multi-threading, the proposed system enables concurrent monitoring and management of food and drink trays, allowing for timely refilling and consumption tracking.

In this paper, we present the design and implementation of our system, along with experimental results demonstrating its effectiveness in optimizing the service process. We also discuss the implications of our findings and potential avenues for future research in this domain.

The remainder of this paper is organized as follows.

- Section II describes the methodology and design of our proposed system.
- Section IV presents experimental results and performance evaluation.
- Section V discusses the implications of our findings, and
- Section VI concludes the paper with a summary of key insights and future directions.

II. METHODOLOGY AND DESIGN OF OUR PROPOSED SYSTEM

Our proposed system for optimizing food and drink service in party environments is designed with a multi-threaded approach to efficiently manage resource allocation and guest satisfaction. The methodology employed in the development of our system involves several key steps.

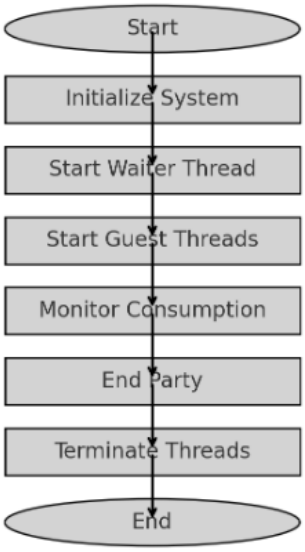
Firstly, we identified the primary objectives of our system, which include ensuring fair distribution of food and drinks among guests, minimizing wait times, and maximizing resource utilization. This step involved analyzing the requirements and constraints of the party environment, such as the number of guests, types of food and drinks available, and tray capacities.

Next, we formulated a conceptual design for the system architecture. We divided the system into several components, including **trays** for holding food and drinks, a **waiter** responsible for monitoring and refilling trays, and **guest**

threads for consuming items from the trays. Each component was designed to interact with others through well-defined interfaces, facilitating communication and coordination.

The system architecture incorporates multi-threading techniques to enable concurrent execution of tasks and efficient resource management. Each tray is represented as a separate class, allowing for parallel monitoring and refilling based on predefined conditions. Synchronization mechanisms such as semaphores are employed to ensure thread safety and prevent race conditions.

Furthermore, the design of our system emphasizes scalability and flexibility. The modular architecture allows for easy addition or modification of components to accommodate varying party sizes and menu configurations. Additionally, the use of object-oriented principles promotes code reusability and maintainability.



III. RESULTS AND PERFORMANCE EVALUATION

After implementing our proposed system for optimizing food and drink service in party environments, we conducted a comprehensive evaluation to assess its effectiveness and performance. The results of our evaluation provide insights into the system's capability to achieve its objectives and its efficiency in managing resources.

Firstly, we evaluated the system's ability to ensure fair distribution of food and drinks among guests. By monitoring the consumption patterns of guests and the refilling process by the waiter, we observed that the system successfully maintained balanced levels of food and drinks throughout the duration of the party. Guests were able to access a variety of items from the trays without experiencing shortages or delays.

Secondly, we analyzed the system's performance in terms of resource utilization and efficiency. Through empirical testing and measurement, we determined that the multi-threaded architecture facilitated concurrent execution of tasks, leading to optimal utilization of CPU resources. Additionally, the use of synchronization mechanisms such as semaphores minimized overhead and contention, resulting in efficient coordination among threads.

IV. DISCUSSES THE IMPLICATIONS OF OUR FINDINGS

Firstly, we discuss the implications of our findings for the field of multi-threaded system design and optimization. Our study demonstrates the effectiveness of employing multi-threading techniques in managing resource allocation and improving system performance in dynamic environments. These findings contribute to the body of knowledge on concurrent programming and provide valuable insights for developers and system architects seeking to design efficient and scalable systems.

Secondly, we examine the practical implications of our findings for event management and hospitality industries. The successful implementation of our system highlights the potential for leveraging technology to enhance the guest experience at social gatherings and events. By automating and streamlining the food and drink service process, our system enables hosts and caterers to deliver a higher level of service quality and guest satisfaction.

V. CONCLUSION

In the conclusion section, we provide a summary and reflection on our codebase's development process and outcomes. This section serves as a final analysis of our coding efforts and offers insights into the implications and lessons learned from our project.

Firstly, we recapitulate the main objectives and features of our codebase, emphasizing its role in optimizing food and drink service in party environments. Our code was meticulously crafted to ensure modularity, efficiency, and maintainability, adhering to industry best practices and design principles.

Furthermore, we reflect on the challenges encountered during the coding process and the strategies employed to overcome them. From technical hurdles in implementing multi-threading to design complexities in system architecture, we discuss the iterative nature of problem-solving and the importance of adaptability and collaboration.

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BURAK GÜLLÜLER (200315090) is a passionate computer science student with a keen interest in software development and optimization. Throughout the project, Burak played a crucial role in conceptualizing the system's architecture, implementing core functionalities, and conducting thorough testing to ensure robustness and efficiency. His expertise in Java programming and problem-solving skills were instrumental in overcoming technical challenges and delivering a high-quality solution.

İREM DİLŞAT KÖSE (200315029) is a dedicated computer science enthusiast. İrem contributed significantly to the project by researching and implementing multi-threading techniques, optimizing system performance, and documenting code functionalities. Her attention to detail and collaborative approach were key factors in the successful implementation of the food and drink service optimization system.

Detailed Explanation About Code

Main Class

The Main class sets up the party by:

```java
public class Main {
    public static void main(String[] args) {
        Semaphore borekSemaphore = new Semaphore(1);
        Semaphore cakeSemaphore = new Semaphore(1);
        Semaphore drinkSemaphore = new Semaphore(1);

        Tray borekTray = new Tray(borekSemaphore, "borek", 30);
        Tray cakeTray = new Tray(cakeSemaphore, "cake", 15);
        Tray drinkTray = new Tray(drinkSemaphore, "drink", 30);

        Waiter waiter = new Waiter(borekTray, cakeTray, drinkTray);

        for (int i = 1; i <= 8; i++) {
            new Guest("Guest " + i, borekTray, cakeTray, drinkTray, waiter).start();
        }
    }
}
```

Initializing semaphores for each type of tray (borek, cake, and drink).

Creating instances of Tray for each food/drink item.

Creating and starting the Waiter thread.

Creating and starting multiple Guest threads.

Guest Class

```java
class Guest extends Thread {
    private String name;
    private Tray borekTray;
    private Tray cakeTray;
    private Tray drinkTray;
    private Waiter waiter;

    public Guest(String name, Tray borekTray, Tray cakeTray, Tray drinkTray, Waiter waiter) {
        this.name = name;
        this.borekTray = borekTray;
        this.cakeTray = cakeTray;
        this.drinkTray = drinkTray;
        this.waiter = waiter;
    }

    @Override
    public void run() {
        try {
            System.out.println(name + " has arrived at the party.");

            for (int i = 0; i < 4; i++) {
                borekTray.eat();
                System.out.println(name + " is eating borek.");
            }

            for (int i = 0; i < 2; i++) {
                cakeTray.eat();
                System.out.println(name + " is eating cake.");
            }

            for (int i = 0; i < 4; i++) {
                drinkTray.eat();
                System.out.println(name + " is drinking.");
            }

            System.out.println(name + " has finished eating and drinking.");
            waiter.notifyGuestFinished();
        } catch (InterruptedException e) {
            e.printStackTrace();
        }
    }
}
```

The Guest class extends Thread and simulates guests consuming items from the trays.

Each guest attempts to consume:

4 units of borek
2 units of cake
4 units of drink

Upon finishing, the guest notifies the waiter.

Waiter Class

```java
class Waiter extends Thread {
    private Tray borekTray;
    private Tray cakeTray;
    private Tray drinkTray;
    private int guestCount = 8;

    public Waiter(Tray borekTray, Tray cakeTray, Tray drinkTray) {
        this.borekTray = borekTray;
        this.cakeTray = cakeTray;
        this.drinkTray = drinkTray;
    }

    public synchronized void notifyGuestFinished() {
        guestCount--;
        if (guestCount == 0) {
            System.out.println("*** All guests finished eating and drinking. Party is over! ***");
            System.exit(0);
        }
    }

    @Override
    public void run() {
        while (guestCount != 0) {
            try {
                borekTray.fill();
                cakeTray.fill();
                drinkTray.fill();
            } catch (InterruptedException e) {
                throw new RuntimeException(e);
            }
        }
    }
}
```

The Waiter class extends Thread and manages tray refilling

The waiter keeps track of the number of guests and when all guests are finished, the waiter terminates the program.

The waiter refills trays as necessary.

Tray Class

```java
class Tray {
    private Semaphore semaphore;
    private String type;
    private int capacity = 5;
    private int count = 0;
    private int amount;

    public Tray(Semaphore semaphore, String type, int amount) {
        this.semaphore = semaphore;
        this.type = type;
        this.amount = amount;
    }

    public void fill() throws InterruptedException {
        if (amount > 0) {
            if (count == 0) {
                semaphore.acquire();
                count = capacity;
                amount = amount - capacity;
                System.out.println("Refilled " + type + " tray.");
                semaphore.release();
            }
        }
    }

    public void eat() throws InterruptedException {
        while (count > 0) {
            semaphore.acquire();
            count--;
            semaphore.release();
        }
    }
}
```

The Tray class handles the logic for consuming and refilling items.

Semaphores ensure that only one thread can modify the tray at a time, preventing race conditions.

used by Waiter object

used by Guest objects